ON A NEW GENUS AND SPECIES OF CARNIVOROUS DINOSAUR FROM THE BELLY RIVER FORMATION OF ALBERTA, WITH A DESCRIPTION OF THE SKULL OF STEPHANOSAURUS MARGINATUS FROM THE SAME HORIZON.*

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The osteological characters of one of the carnivorous dinosaurs of the Cretaceous are revealed in a wonderful manner by a nearly complete skeleton obtained last summer by the Vertebrate Palæontological expedition of the Geological Survey of Canada to Red Deer river, Alberta, where a magnificent collection of dinosaurian and other reptilian remains was obtained from the Belly River formation. The expedition was in charge of Mr. Charles H. Sternberg, and this skeleton was discovered by his son, Charles M. Sternberg, 3½ miles below the mouth of Berry creek (Steveville), on the south side of Red Deer river, near the prairie level.

The specimen includes the head, the greater part of the vertebral column, the pectoral and pelvic arches, one at least of the fore-limbs complete, both hind-limbs also complete, the ribs, and apparently the entire series of abdominal ribs. The cervical vertebræ appear to be missing, but as all of the sandstone matrix has not yet been removed, they, or some of them, as well as the other fore-limb, may yet be uncovered. The extreme end of the tail, back of the twenty-second caudal vertebra, was not found.

The mandible is present and all of the teeth, both upper and lower, are in place, giving the complete dentition. The writer has already published a short description of the fore-limb,** which has not hitherto been known in any of the Cretaceous carnivorous dinosaurs. Nor has a complete series of ventral ribs in any of these reptiles previously been discovered.

For the undescribed genus of Theropodous dinosaur, brought to light by this magnificent specimen, the name Gorgosaurus is proposed. The species may be called *libratus* in reference to the animal's probable well-balanced and easy gait.

GORGOSAURUS LIBRATUS, gen. et sp. nov.

Carnivorous dinosaur of large size, reaching a length of about twenty-nine feet; head narrow and moderately elongate;

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trunk compact; fore-limbs minute; hind-limbs long and robust; tail nearly half the total length of the animal, tapering, and with only a slight lateral compression. In the skull there is a large antorbital vacuity, preceded by a very small opening in the centre of a depressed area. No triangular alveolar plates on the inner sides of the jaws. A foramen present in the surangular, far back and near its upper border. No presplenial. Teeth trenchant, powerful, 4 premaxillary, 13 maxillary and 14 dentary. First tooth of the maxilla similar in shape and size to those of the premaxilla. Vertebræ slightly amphicoelous, concave on the sides and beneath; 2 cervico-dorsals, 11 dorsals, 5 sacrals, and about 34 caudals. Neural spines short throughout the vertebral column. Chevron bones short, beginning with the first caudal. Transverse processes of the caudal vertebræ decreasing in size to and ending with the 14th vertebra. Anterior zygapophyses of the posterior caudals greatly lengthened. Scapula longer than the fore-limb. Humerus twice the length of the ulna. Two digits, Nos. II and III, to the manus, of which the phalangeal formula is 2 II, 3 III, the terminal phalanges being claw-bones. Metacarpal IV represented by a proximal vestigial bone. Ilium elongate, plate-like, with a flat upper outline and rounded ends. Preacetabular part shorter than the hinder portion, of which both are strengthened on the outer surface by a prominent, overhanging flange running horizontally at midheight. Ischium terminating narrowly below. Pubis ending in a horizontally expanded foot, of which the posterior extension is the greater. Femur about the same length as the tibia. Metatarsals II, III and IV elongate, of which III, the longest, is nearly two-thirds the length of the femur. Metatarsal I represented distally by a short vestigial bone, and metatarsal V represented in a similar manner proximally. Four clawed digits to the pes, viz.: Nos. I, II, III and IV, of which the phalangeal formula is 2 I, 3 II, 4 III and 5 IV. Ventral ribs composite, sixteen in number, overlapping at the longitudinal mid-line of the body, and bearing distally slender, closely applied supplementaries.

Gorgosaurus libratus, apart from its dentition, is remarkable for the extreme shortness of the fore-legs and the great length of the hind ones. The long, narrow ilium rises slightly above the short sacral spines, and, in addition to the horizontal flanges, already mentioned, there are two small strengthening buttresses running upward from the centre of the acetabular border. The length of the metatarsals is surprising. The close application of the vestigial distal end of metatarsal I to metatarsal II is indicated by a slightly concave surface on the latter bone, which

gives digit I a forwardly rather than a backwardly directed position in the foot, The vestigial proximal end of metatarsal V is in place in each leg, recalling to mind a similarly reduced bone in *Ornithomimus altus*, Lambe, also from the Belly River formation of Alberta.

Each abdominal rib consists of two well ossified, flattened lengths, which overlap at their inner ends. Outwardly, each lateral half is slightly grooved on its front margin for the reception of a slender rod-like bone (supplementary), which lies closely against the rib and projects but slightly beyond its outer end.

The four premaxillary teeth are remarkably long and slender, with a keel on each side of a slightly convex inner or lingual surface. They are latterly compressed to a slight extent, evenly rounded in front, with their fore and aft diameter a little greater than their breadth. The first or anterior tooth of the maxilla is similar to the premaxillary teeth, in which respect Gorgosaurus differs from other known genera of Cretaceous carnivorous dinosaurs. The other maxillary teeth are long and powerful, of the Megalosauroid type, with two serrated keels, one along the front edge, the other behind. In the second maxillary tooth the anterior keel in descending passes slightly toward the inner side of the crown, and this is seen in a lessening degree in the next two or three succeeding teeth. A similar slight variation is seen also in the more anterior teeth of the dentary.

The chevron bones are intervertebral, but with a greater surface of attachment to the front vertebra of the two, The more anterior ones are bent slightly backward from their mid-length. This angulation in succeeding ones becomes more pronounced until the lower edge of the distal half is parallel to the longitudinal axis of the tail. By a gradually increased development and prolongation forward of the anterior angulation at the mid-length of the bone, a "meat-chopper" shape is attained and adhered to with a gradual diminution in size, more apparent in the depth of the bone than in the length of its "foot."

The long and slender anterior teeth (premaxillary and first maxillary) of Gorgosaurus are very different in shape from the robust supposed anterior teeth of *Deinodon horridus* of Leidy. In all the large Cretaceous carnivorous dinosaurs, the majority of the teeth, apart from the more anterior ones, are remarkably similar in the different genera and do not afford data for generic distinctions.

Another large form of carnivorous dinosaur, having supporting alveolar plates on the inner sides of the jaws, occurs in the Belly River formation of Alberta and is represented in the collection of 1913.

MEASUREMENTS.

	Feet.	Inches.
Total length of specimen (estimated)	29	2
Skull, length to occipital condyle (approx)	3	2
" depth to lower border of maxilla, through middle of antorbital opening	1	0
" depth to lower border of dentary, through middle of same opening	1	$9\frac{3}{4}$
Mandible, length of	3	$2\frac{1}{4}$
Third premaxillary tooth,		
Length below alveolar margin		2
Breadth at midlength		$0\frac{3}{8}$
First maxillary tooth,		
Length below alveolar margin		$1\frac{7}{8}$
Breadth at midlength		$0\frac{3}{8}$
Second maxillary tooth,		
Length below alveolar margin		$2\frac{1}{2}$
Fore and aft diameter		$0\frac{7}{8}$
Transverse diameter		$0\frac{5}{8}$
Maxillary tooth, longest (6th), length below alveolar margin		$3\frac{7}{8}$
Dentary tooth, longest (5th), length above alveolar margin		$2\frac{5}{8}$
Cervical vertebræ (atlas, axis, 7 cervicals and 2 cervico-dorsals), estimated length	4	4
Dorsal vertebræ with sacrum (11 dorsal, 5 sacral)	7	6
Caudal vertebræ, 1st to 22nd, both inclusive	10	4
" " 23rd to 34th, both inclusive (estimated)	3	10
Scapula with coracoid, length	3	5
Humerus, length		$12\frac{3}{4}$
Ulna, length		$6\frac{1}{2}$
Radius, length		$6\frac{1}{8}$
Ilium, length (antero-posterior)	3	$3\frac{1}{4}$
Ilium, height above lower end of ischial peduncle	1	2
Ischium, length	2	$8\frac{3}{4}$
Pubis, length	3	$3\frac{1}{4}$
Pubis, fore and aft length of foot of	1	10
Femur, length	3	$4\frac{1}{4}$
Tibia (including astragalus), length	3	4

Tibia, length	3	3
Metatarsal, I, length		4½
" II, "	1	9½
" III, "	2	0½
" IV, "	1	10
" V, "		8½
Digit I of pes, length		8
" II " "	1	4¾
" III " "	1	8
" IV " "	1	4½
1st Dorsal vertebra, length of centrum of		3½
3rd " " " "		4
2nd Rib, length	3	9
Posterior sacral vertebra, length of centrum of		6½
1st Caudal vertebra, length of centrum of		6
" " " height of anterior end of centrum of		7½
5th Caudal vertebra, length of centrum of		6
" " " height of centrum of, × neural spine		11½
" " " length of chevron bone of		8
12th " " length of centrum of		5¾
" " " height of anterior end of centrum of		3½
22nd " " length of centrum of		4⅜
" " " height of anterior end of centrum of		1⅞
" " " fore and aft length of foot of chevron bone of		4
5th Abdominal rib, length of lateral half of	2	1¼
Outer supplementary of same, length of		9¾

STEPHANOSAURUS, gen. nov.

This genus is established for the reception of the species from the Belly River formation of Alberta, originally described, under the name of *Trachodon marginatus*, by the writer in 1902* from a ramus of a lower jaw and a maxilla, and from the remains of one individual. With the species were provisionally associated other elements, notably a slender footed-ischium, which associations have since been proved to be correct by further material included in the collection of 1913 from the Belly River formation of Red Deer river. These additional remains, discovered by

*Contributions to Canadian Palæontology, Vol. III (quarto), pt. II.

Mr. Charles H. Sternberg, are of two individuals to which the writer has lately referred† in describing the integument of the species. With one of these specimens the skull reproduced in plate I is preserved. Part of another skull (collection of 1913), found separately, assists in elucidating the characters displayed by the more perfect skull, and provides additional evidence regarding some of those elements to whose great development is mainly due the surprising shape of the head of this species.

The skull of Stephanosaurus rises to a great height in front of and above the eye opening. In recently describing Gryposaurus, also from the Belly River formation of Alberta, the writer commented on the anterior depth of the skull occasioned by the height to which the nasal rose. In the skull of Stephanosaurus, however, the height attained by the nasals is proportionately twice as great as in Gryposaurus; the depth of the skull above its midlength is equal to its total length. Viewing the skull from the side, the facial outline is sigmoid, at first concave, ascending rapidly from the front until it is vertical, whence it continues upward and reaches a point directly above by an even convex curve; this, the highest point preserved in the specimen, is vertically above the midlength of the skull. The general slope of the head behind is rapidly downward to the squamosal, but as this part of the specimen is imperfect, the exact outline is unknown. The almost vertical quadrate and the sinuous horizontal contour of the slender mandible below complete the profile of the head.

The orbit is small and its centre is below the midheight of the skull.

The enlargement of the skull in front of and above the orbit is due to the great development mainly of the prefrontal and nasal bones, the latter of which rises upward in front of the prefrontal and passes backward over it and beyond it. This extension of the nasal beyond the upper limit of the prefrontal appears to be supported from below by the frontal, although this last bone has not been satisfactorily recognized. Above the prefrontal and the supposed frontal, the nasal points almost directly upward. In the specimen its upper termination has been broken off, but it probably formed with the other nasal a stout spine somewhat of the shape suggested by the dotted outline in the figure.

The prefrontal is a large triangular bone with its base resting for the most part on the lachrymal, which latter is long and

† The Ottawa Naturalist, Vol. XXVII, No. 10, January, 1914.

narrow, meets the jugal below, and posteriorly enters largely into the formation of the orbital rim.

By referring to the figure it will be seen that the maxilla, the jugal, the quadrato-jugal, the quadrate, and the mandible have much the same proportions as in Trachodon. The jugal is small, but it has the general shape characteristic of this element in all known members of the Trachodontidæ.

Anteriorly, the premaxilla is somewhat depressed, but laterally much expanded. Its upper surface, next to the median line of the head, is continued in a curve outward anteriorly and backward laterally as a marginal area enclosing a wide depression in advance of the long and narrow nasal opening. In the specimen, the outermost portion of the laterally expanded premaxilla is crushed down. The nasal opening is enclosed above by the nasal and below by a backwardly directed extension of the premaxilla. This extension, or lower limb, of the premaxilla passes along the upper front surface of the maxilla and abuts against the prefrontal. Above, posteriorly, it unites with the nasal behind the nasal opening in a short sutural contact. It is not known how far forward the nasal extends, as its suture with the premaxilla in front has not been detected.

The squamosal is preserved in part, as shewn in the figure. The postfrontal is probably represented toward its anterior end, but here its limits are not recognized, and posteriorly the bone is imperfect. As in other members of the Trachodontidæ, it no doubt contributed to the formation of the postorbital bar.

The orbital opening is narrowly elliptical, with its longer diameter directed obliquely downward and forward. It is more than twice as long as wide. The lateral temporal fossa is larger than the orbit and is also longer than wide, with a similar obliquity of length.

Detailed descriptions, with illustrations, of the maxilla, the mandible, the teeth, the ischium, the pubis, and the principal bones of the fore- and hind-limbs of *Stephanosaurus marginatus* were published when the writer established the species in 1902. The characters of the integument are known from the writer's recent description (op. cit.).

The nearest approach to Stephanosaurus is Saurolophus of Brown from a higher horizon of the Cretaceous of Alberta (Edmonton formation). In this latter genus the facial slope of the skull is about midway between that of Stephanosaurus and Trachodon. The upwardly directed nasal spine of Stephanosaurus may have heralded the backwardly sloping nasal crest

of the later Edmonton dinosaur. The two genera appear to be closely allied and in both the footed form of ischium is present.

EXPLANATION OF PLATE I.

Left lateral aspect of skull of *Stephanosaurus marginatus*; one-fifth the natural size.

Abbreviations.—*D*, lateral temporal fossa; *DN*, dentary; *J*, jugal; *L*, lachrymal; *MX*, maxilla; *N*, nasal; *NO*, nasal opening; *OR*, orbit; *PD*, predentary; *PF*, prefrontal; *PM*, premaxilla; *Q*, quadrate; *QJ*, quadrato-jugal; *S*, squamosal; *SA*, surangular.

THE LONDON BIOLOGICAL CLUB.

This club, which was formed on February 6th last, has twenty chartered members. It is the intention to hold monthly meetings and conduct field excursions. On March 6th, Dr. Hill, of the Institute of Public Health, gave an address on "Life", and on April 3rd Dr. Woolverton delivered a lecture on "The Mammoth Cave".

Recently the club presented a memorial to the Honourable Minister of Game and Fisheries, Toronto, which called attention to many native birds which have become seriously depleted in numbers, chiefly owing to shooting by sportsmen and others. Direction was drawn to the scarcity of quail in certain localities and the hope expressed that continuous protection be given so that the birds would have every chance to recover, in time, their former numbers. Other birds mentioned were the Eagle, Fish Hawk and Great Blue Heron, which have now become exceedingly rare. Many of the beneficial smaller birds are also in need of protection. In the opinion of the club, the easiest way to increase the amount of protection given by the present laws is to enact and enforce a license for all firearms except military rifles, which would prevent a great deal of the thoughtless slaughter at present carried on.

It was also suggested that the Government purchase abandoned woods and other cheap areas of land and marsh on which hunting could be prohibited, thereby forming breeding sanctuaries.

The officers of the London Biological Club are: President, Dr. H. W. Hill; Vice-President, Dr. S. Woolverton; Curator, Mr. J. F. Calvert; Secretary-Treasurer, Mr. J. W. Noble.

We extend to this new sister club our warmest greetings and best wishes for success in all branches of its work. The motto of the club, "Learn to live and live to learn," is an ideal one.

A. G.


N.
PF.
OR.
S.
D.
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